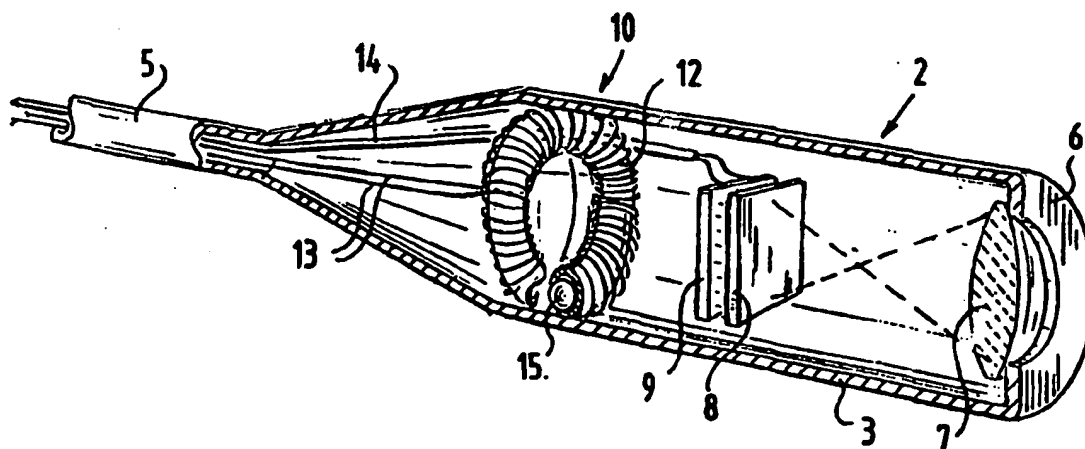


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/BE94/00042 <b>(22) International Filing Date:</b> 7 July 1994 (07.07.94)  <b>(30) Priority Data:</b> 9301210                      9 July 1993 (09.07.93)                      NL  <b>(71) Applicant (for all designated States except US):</b> SATURNUS A.G. [LU/LU]; 11, rue Aldringen, L-2960 Luxembourg (LU).  <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> KONINCKX, Robert, Philippe [BE/BE]; Vuilenbos 2, B-3360 Bierbeek (BE).  <b>(74) Agent:</b> EVELEENS MAARSE, Pieter, Arnold & Siedsma BVBA, Hamoiriaan 21A, B-1180 Brussel (BE).		<b>(81) Designated States:</b> AU, CA, JP, NZ, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i> <i>In English translation (filed in Dutch).</i>

(54) Title: TV CAMERA WITH ROTATIONAL ORIENTATION CORRECTION



## (57) Abstract

The invention relates to a device for reproducing an image of a poorly accessible location, for example in a living body, comprising a substantially cylindrical image pick-up unit (2) to be arranged at the location and an image display means (fig. 5) connected to the image pick-up unit, wherein the image pick-up unit (2) is provided with indication means (10) for indicating the rotation position of the image pick-up unit on its axis relative to the horizontal. As a result of these steps it is possible to give an indication of the horizontal, or for example the vertical, on the image reproduced on the image display means, so that the orientation of the displayed image is known, or by processing the displayed image or by turning the image display means such that the orientation of the displayed image corresponds with the actual orientation. Dangerous situations, for instance during performance of an operation, can herewith be avoided.

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## TV camera with rotational orientation correction

The invention relates to a device for reproducing an image of a poorly accessible location, for example in a living body, comprising a substantially cylindrical image pick-up unit to be arranged at the location and an image display means connected to the image pick-up unit.

Such devices, generally known in for example medical technology, are used for instance to reproduce images from inaccessible places of a living body. Such image pick-up units are herein pushed into the often narrow channels in a body, which channels may for example be formed by veins or arteries or intestines for example, so that the dimensions of such an image pick-up unit have to be very small, for example with a transverse dimension in the order of magnitude of a few millimetres.

In respect of the usually substantially circular section of such channels such image pick-up units are likewise usually given a cylindrical form. With these cylindrical image pick-up units there is therefore the danger that they will rotate on their axis. When these image pick-up units rotate inside the channel, the image hereby picked up will likewise be transmitted to the image display means rotated relative to the horizontal. When no clear reference to the horizontal is present in the image, as is mostly the case when picking up images inside a body, the orientation of the image reproduced on the image display means is unknown.

Resulting herefrom is therefore an image for which the transmitted information is incomplete.

When the displayed image is used in performing an operation, dangerous situations can therefore arise. It is thus possible for instance that, as a result of the inaccurate display, an incision which is intended to extend between two intestines extends transversely along the intestines.

In such applications it is known for example to have

water drip in front of the camera so that a reference relative to the vertical, and therefore automatically also relative to the horizontal, is obtained. This is awkward however and nothing like possible in all situations.

Attempts are also made, for example with the help of an assistant, to continuously maintain the position of the image pick-up unit on the basis of a known position.

Another typical manner is to reciprocally move an endoscope in which a camera is situated. From the movement on the screen resulting herefrom the deviation of the angle relative to the horizontal can be determined. Correction can take place by rotation of the camera.

The object of the present invention is to provide such a device, wherein the above stated problems are avoided.

This object is achieved in that the image pick-up unit is provided with indication means for indicating the rotation position of the image pick-up unit on its axis relative to the horizontal.

As a result of these steps it is possible to give an indication of the horizontal, or for example the vertical, on the image reproduced on the image display means, so that the orientation of the displayed image is known, or by processing the displayed image or by turning the image display means such that the orientation of the displayed image corresponds with the actual orientation.

The invention will subsequently be elucidated with reference to the annexed drawings, in which:

fig. 1 is a partly broken away view of a first embodiment of an image pick-up unit arranged in a channel in the body;

fig. 2 is a partly broken away enlarged perspective view of the image pick-up unit depicted in fig. 1;

fig. 3 shows a second embodiment of an image pick-up unit according to the present invention;

fig. 4 shows a third embodiment of an image pick-up unit according to the present invention; and

fig. 5 shows an embodiment of a reproducing device which is provided with a correction device according to the invention.

5 In the situation depicted in fig. 1 a channel 1 is shown which is formed for example by a blood vessel in a human body. Situated in channel 1 is an image pick-up unit 2 which is received in a cylindrical housing 3 and which transposes into a cable 5 via a conical part 4. A lens 7 is arranged in the front surface 6 of the image  
10 pick-up unit. As a result of the rotation symmetrical form of this image pick-up unit there is a danger that it will rotate inside the channel 1.

The pick-up unit 2 is shown in more detail in fig. 2. It can be seen here that image pick-up unit 2 is provided  
15 with an image pick-up element 8 in the form of a CCD board which is connected to an electronic circuit 9 located therebehind in which the signal is processed for transmitting thereof via the cable 5 to an image display device placed outside the body.

20 This image pick-up unit in the form of the shown video camera can of course be equipped with other components of less importance to the present invention, such as a displacing device for the lens in order to enable focusing of the image reproduced on the CCD element 8. In  
25 general the lens 7 will therefore be formed by a lens assembly consisting of various elements. A form of diaphragm can also be arranged.

In order to prevent the problems referred to in the preamble a position pick-up means 10 is arranged in the  
30 form of a toroidal tube 11 which is made for example of plastic and around which is arranged a winding 12. Arranged in the hollow space of the toroidal tube 11 is a ball 15 which can rotate freely inside the tube and which will always occupy the lowest position as a result of the  
35 force of gravity. This position is sensed by the winding which transmits a relevant signal via the cable 13. This is transmitted to the image display device together with

the signal representing the image transported via the cable 14. In the image display device such an indication can be given for example by an arrow or a triangle on the top side of the displayed image. The surgeon for instance is thus informed that the displayed image is rotated relative to the horizontal.

It is of course possible to use other forms of rotation pick-up means, for example rotation acceleration pick-up means. The construction of such rotation acceleration pick-up means is known; they are even commercially available, so will not be discussed here. It is even possible to apply displacement acceleration pick-up means so that not only the rotation position of the image pick-up units is known but also the position thereof in the body. It will be apparent that three acceleration pick-up means are necessary to determine the position. The use of acceleration pick-up means of course entails the application of integrators. Such an application also enables correction of any vibration of the image.

Use is also made of image pick-up units of which the image pick-up surface extends obliquely relative to the rotation axis of the pick-up unit. Herein, when the image pick-up units rotate, the displayed image will not only rotate but also change; the image pick-up units are "looking" the other way.

Before the image is reproduced visually the uncorrected signal together with the correction signal or the signal corrected using the correction signal can be stored in analog or digital form on a recording medium.

In fig. 3 another embodiment of an image pick-up unit is shown. This is formed by an optical fibre 25 which leads to a video camera 26. A rotation pick-up means 27 is arranged on the engaging surface of the light conductor 25, so that in this situation rotations of the pick-up means in the form of the optical conductor can also be corrected.

Fig. 4 shows a third embodiment of an image pick-up

unit according to the invention. This embodiment is particularly suitable for applications with intra-abdominal endoscopic surgery. A laparoscope 29 is herein introduced into the abdominal cavity 30 by means of a trocar 28. The part of the laparoscope 29 remaining outside the abdominal cavity is situated in the vicinity of a camera 31, wherein it is possible to rotate the laparoscope 29 inside the trocar 28. This is important in the first instance in order to obtain different images from the laparoscope 29. The latter is in any case provided with an oblique pick-up surface 32 that looks away "obliquely". By rotating laparoscope 29 a field of vision can thus be obtained which is formed by a collection of separate images, wherein the central lines of the images form a cone. The field of vision is hereby considerably enlarged compared to a situation where it is only possible to look "straight ahead". Instruments are often carried simultaneously by the same trocar, wherein the operations performed can be viewed carefully using the laparoscope. It should be otherwise noted that the laparoscope can rotate relative to the camera. In these situations a direction indication according to the invention is also of the greatest importance.

It will otherwise be apparent that the camera can also be fixed on the internal end of the laparoscope.

An example of an image display device is shown in fig. 5. This is formed by a cathode ray tube, the construction of which is assumed known. This cathode ray tube comprises an electrode gun 16, a set of vertical deflecting plates 17, 18, and a set of horizontal deflecting plates 19, 20, which deflecting plates 17-20 are arranged together in a frame 21. This frame is arranged for rotation by means of a servomotor 22. The electron bundle coming from the electron gun 16 falls on a screen 23 and is reproduced there. By thus driving the electric motor 22 with the signal coming from position pick-up means 10 the position of the plates 17-20 is corrected, so that the

image reproduced on the display 23 assumes the correct position, and is corrected for rotation of the camera position. It will be apparent that the signal coming from the pick-up unit will have to be amplified before it is  
5 fed to the servomotor.

It is likewise possible to rotate the entire picture tube or to process the signal representing the image such that the horizontal in the image is actually displayed horizontally.



**CLAIMS**

1. Device for reproducing an image of a poorly accessible location, for example in a living body, comprising a substantially cylindrical image pick-up unit to be arranged at the location and an image display means connected to the image pick-up unit, characterized in that the image pick-up unit is provided with indication means for indicating the rotation position of the image pick-up unit on its axis relative to the horizontal.

2. Device as claimed in claim 1, characterized in that the image display means is provided with means for correcting the position of the displayed image relative to the horizontal.

3. Device as claimed in claim 1, characterized in that the indication means are adapted to generate a correction signal representing the rotation position.

4. Device as claimed in claim 1, 2 or 3, characterized in that the image pick-up unit is a video camera.

5. Device as claimed in claim 1, 2 or 3, characterized in that the image pick-up unit is formed by the engaging surface of an optical fibre, which fibre leads to a video camera disposed elsewhere.

6. Device as claimed in claim 4 or 5, characterized in that the image pick-up unit has an engaging surface which extends at an angle differing from 90° relative to the axis of the pick-up unit.

7. Device as claimed in claim 6, characterized in that the image pick-up unit is rotatable around the pick-up axis.

8. Device as claimed in claim 2, characterized in that the image display means has a display surface that is rotatable round a central axis.

9. Device as claimed in claim 2, characterized in that the image display means is a cathode ray tube, the plates of which are rotatable round the axis.

10. Device as claimed in claim 2, characterized in that the image display means is provided with electronic correction means for correcting the rotation position of the reproduced image, wherein the correction signal is fed to the correction means.

11. Device as claimed in claim 2, characterized in that the image display means is provided with indication means for indicating the rotation position of the displayed image.

12. Device as claimed in any of the foregoing claims, characterized by a storage means for storing in a storage medium the signal coming from the image display means.

13. Device as claimed in claim 12, characterized in that the storage means is adapted to store the signal together with the correction signal.

14. Device as claimed in claim 12, characterized in that the storage means is adapted to store the signal corrected using the correction signal.

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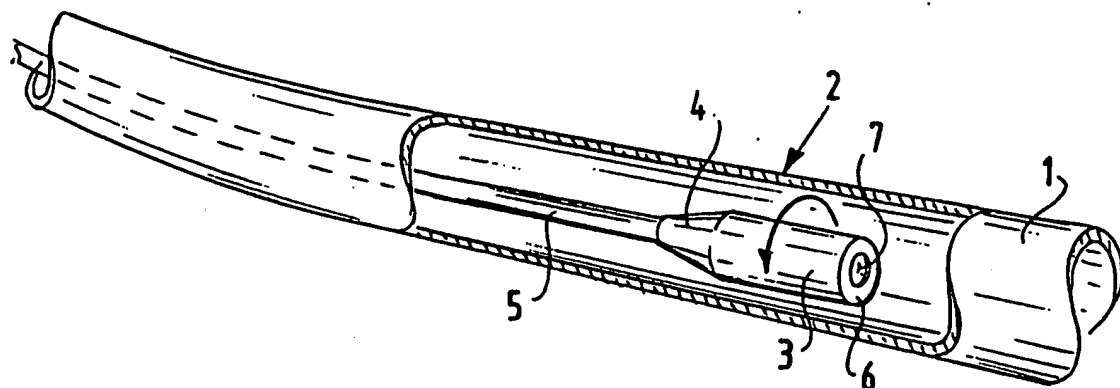


FIG. 1.

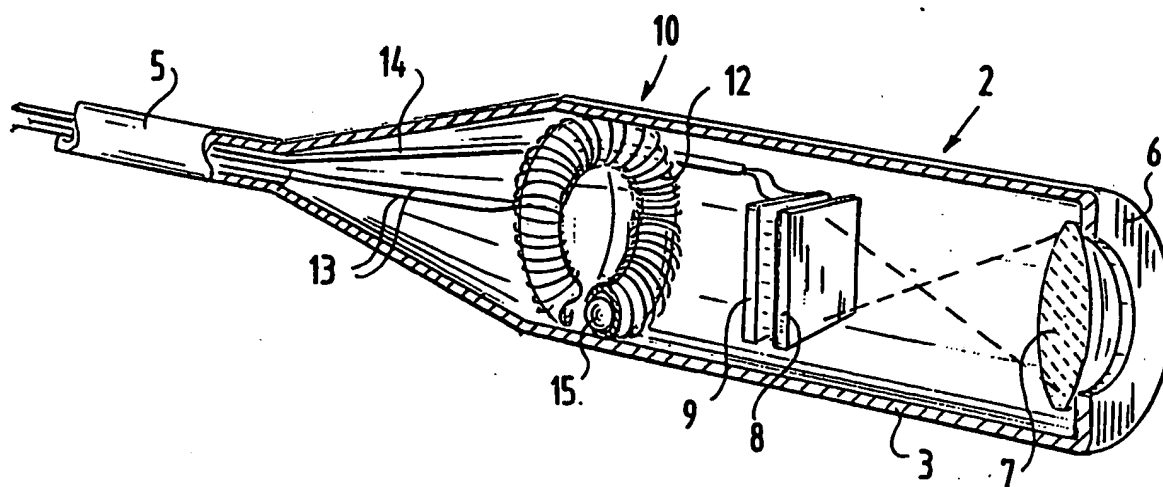


FIG. 2

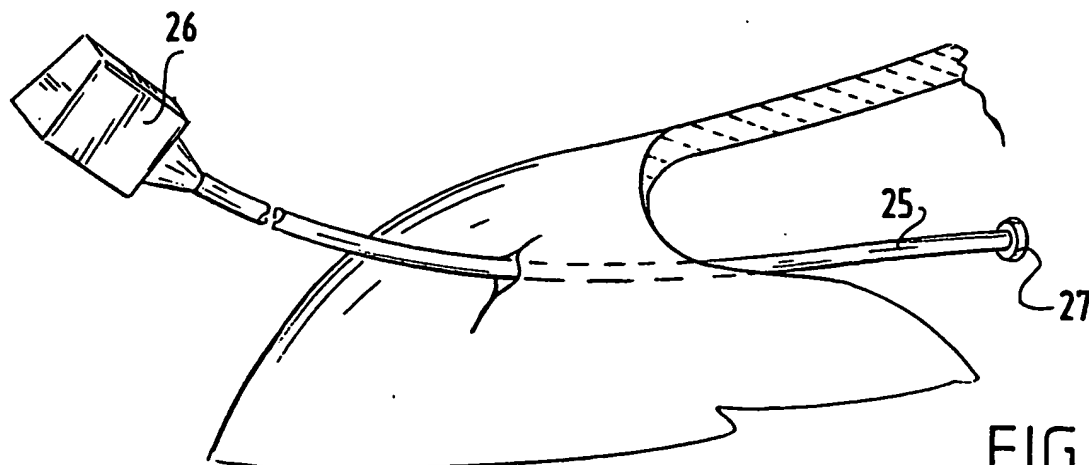


FIG. 3

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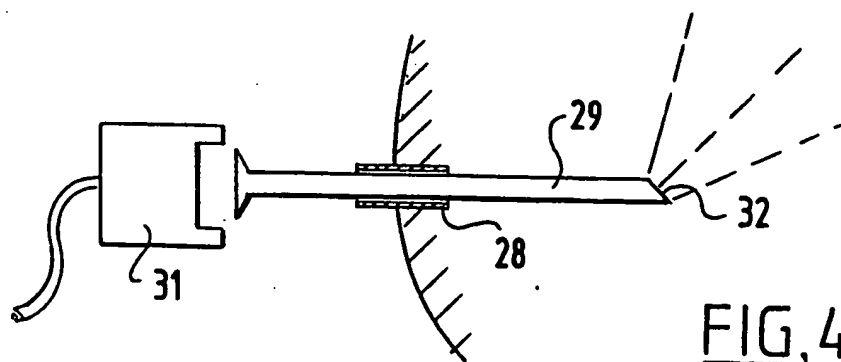


FIG. 4

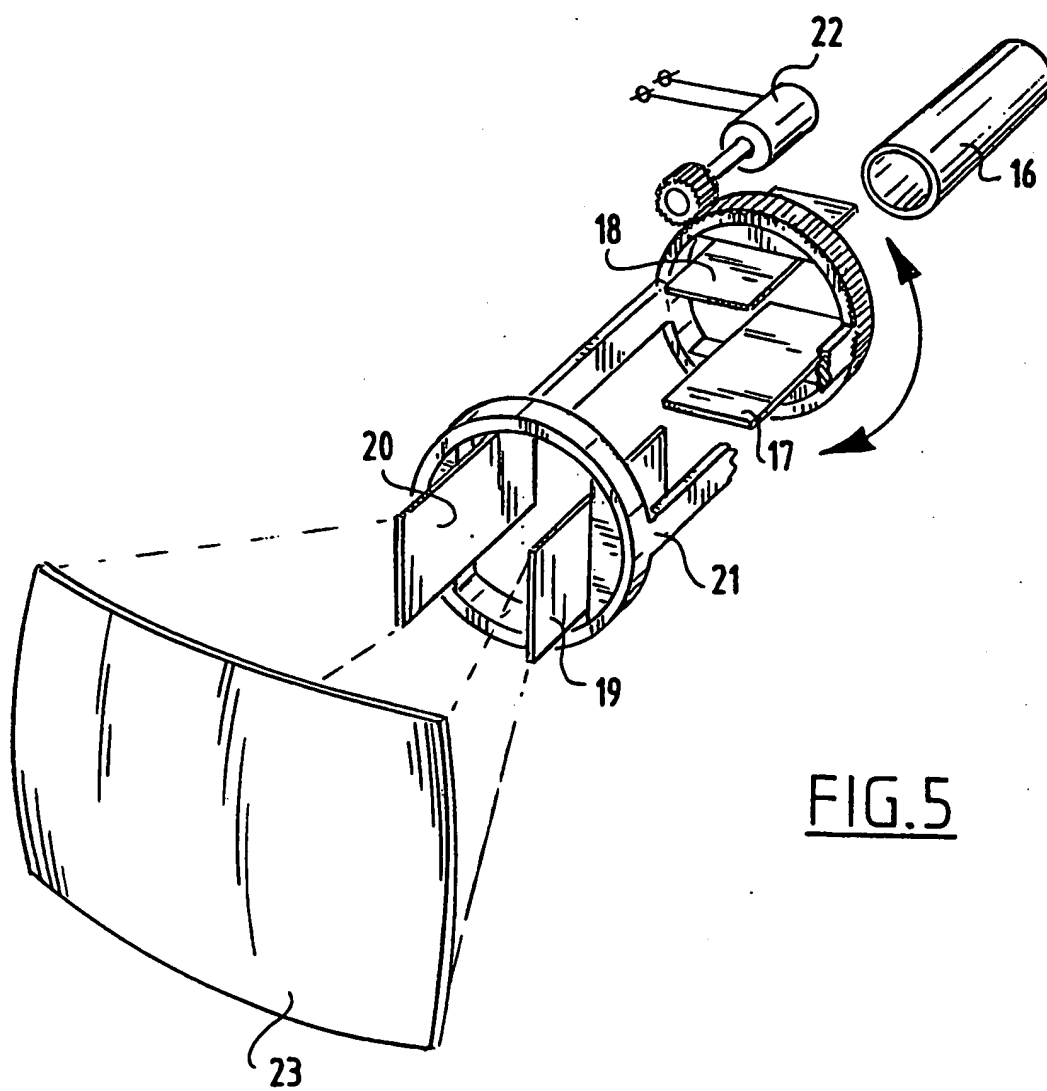


FIG. 5

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 A61B1/05 G01C9/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 A61B G01C H01J

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US,A,4 880 011 (S.IMADE ET AL.) 14 November 1989 see the whole document ---	1,2
Y	DE,A,41 02 196 (OLYMPUS OPTICAL CO. LTD.) 1 August 1991 see the whole document ---	1,2,4, 10,12-14 6,7,11
A		
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Date of the actual completion of the international search

27 September 1994

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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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